

A set of questions/issues to the general directional exam checking the level of the knowledge of the Mechatronic Engineering study course and for the entrance examination for the second degree studies in Mechatronic Engineering

Below are only the wordings of the questions/topics. During the test, students/candidates will receive sets of questions prepared based on this list. Each question will be contain four answers, including the only one correct. The student/candidate should select and indicate one correct answer.

BASICS OF INFORMATICS

1. An 8-bit microprocessor has added (4AH+61H) in two's complement representation. The result and states of flags (C-carry, V-overflow) are:
2. A directory listing contained the following line: *lrwxrw-r-- 1 lm lm 16 Oct 12 11:05 sources -> /home/lm/sources*. It represents:
3. The command: *lm@arch:~% ls /usr/bin | grep -E '(bze|grep)'*
4. The following script

```
#!/bin/bash
ParInfo() {
echo "ParInfo(): $1 = $1, $2 = $2"
}
ParInfo $2 $3
```


was saved into a file *ExamParInfoFun* and executed using command:
lm@arch:~% ./ExamParInfoFun Exam Par Info Fun
The result is:
5. Arrays in C have the property:
6. Structures in C have the property:
7. Pointers in C have the property:
8. Functions in C have the property:
9. Operating system processes have the property:
10. Operating system threads have the property:

PHYSICS

11. How is oriented the acceleration vector in curvilinear motion of a point?
12. Which forces are included to the group of forces of inertia?
13. Give the correct definition of work.
14. Work of conservative force along a closed curve.

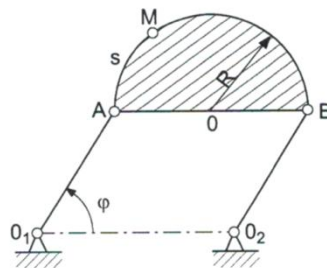
15. What kind of time function is the amplitude of successive deflections for the phenomenon of damped harmonic vibration (in the case of weak damping)?
16. Frequency of forced harmonic vibration.
17. Enter the correct formula for the intensity of the gravitational field produced by the system of masses.
18. Indicate why the mass of the rigid body is not a good measure of its inertia in a rotating motion?
19. The gyroscopic effects are the consequence of what kind of phenomena?
20. What is the purpose of the lift force acting on an aircraft wing (according to the Bernoulli law)?
21. Indicate the kinetic energy of the speeding particle of nonzero mass, whose velocity approaches the speed of light (according to the theory of relativity).
22. In the electric field was introduced test electric charge $\vec{E}$. Knowing the force acting on the test electric charge and the amount of that charge with which quantities you can determine the value of that field?
23. How to calculate the value of the field intensity $\vec{E}$ generated by the three charges?
24. Between points A and B spaced apart by a distance L is stretched and homogeneous electric field. The potential difference between points is ΔV . What is the absolute value of the intensity of this field?
25. What is the dielectric polarization?
26. On the conductor of mass m was placed the charge of Q . As the result of that its potential has increased by value ΔV . How is defined the electrical capacitance of that conductor?
27. Resistance of the conductor of length L , cross-sectional area S and resistance ρ , meets Ohm's law applicability. How the resistance depends on the size of given above quantities?
28. In the apartment we assume for the installation of three sockets for devices operating at a voltage of 220 V. What is the correct installation of the socket connections with a voltage source?
29. Into magnetic field drops the charged particle with charge Q in direction parallel to the induction vector $\vec{B}$. Velocity of a particle is $\vec{v}$. What kind of motion is particle moving?
30. Closed circuit with the conductor was placed in a magnetic field of induction $\vec{B}$. As a result of which phenomenon was generated the current in that inductive circuit?
31. The existence of a field $\vec{E}$ generated by stationary charges is described by the Maxwell equation. Select the correct formula:
32. Coherent light falls on two narrow slots. After passing through the two light rays meet with the same phase at a point equidistant from the slots. What is the resultant intensity of light at the two slots opened if the light intensity value measured at one closed slot is equal to I_0 ?
33. Who has formulated the correct description of thermal radiation?
34. Stefan-Boltzmann law.

35. Bohr model of the hydrogen atom.
36. What is the threshold energy on the creation of electron-positron pair?
37. Indicate the valid state of thermal equilibrium of two systems.
38. For what allows the zero law of thermodynamics?
39. How can you calculate the increase in entropy for small transfers of heat?
40. What is the adiabatic diagram in the coordinates (p, V) ?
41. What is the efficiency of any engine operating between the reservoir of heat at a temperature of T_1 and cooler with the temperature T_2 ?
42. If the perfect blackbody temperature has increased 2-times, what the change of radiation power is caused?
43. How is changed the maximum radiation power with the temperature increase according to Wien's displacement law?
44. What is the spectrum of atomic hydrogen?
45. What is the value of the Bohr magneton?
46. What devices are working with the use of electromagnetic induction phenomenon?
47. What information is contained in the Ampere law, generalized by Maxwell?
48. What is the necessary condition for liquefaction of gas?
49. What is omitted in the model of an ideal gas?
50. How the temperature changes in the adiabatic process of gas with the increase of its volume?
51. What determines the internal energy of one mole of ideal gas?
52. What determines the internal energy of the system?
53. What are the thermodynamic conditions under which the engine can convert heat into work?

MECHANICS 1 / MECHANICS 2

54. Definition of force.
55. Equilibrium conditions for a planar (2D) concurrent force system.
56. Equilibrium equations for 3 force members.
57. A moment of a force about an axis, rectangular components of a moment.
58. A case of reduction of a force system for which the resultant force W_g and the resultant moment M_g : $\vec{W}_g \neq 0, \vec{M}_g \neq 0, \angle(\vec{W}_g, \vec{M}_g) = 0^\circ$.
59. A case of reduction of a force system for which the resultant force W_g and the resultant moment M_g : $\vec{W}_g \neq 0, \vec{M}_g \neq 0, \angle(\vec{W}_g, \vec{M}_g) = 90^\circ$.
60. Definition of kinematics.
61. Vector of acceleration of a particle in uniform motion.
62. Acceleration of a particle motion defined by rectangular components of the particle's position vector (motion equations).
63. Determination of a distance of a particle's motion described by the path coordinate.
64. Curvilinear coordinates.

65. Definition of uniform motion.
66. Determination of acceleration of a particle in general (compound) motion.
67. Coriolis acceleration.
68. Uniform motion of a rigid body.
69. General plane motion of a rigid body.
70. Definition of centroids.
71. Acceleration vector of a point of a rigid body in the general plane motion.
72. What kind of material bodies are considered in the Newton's laws.
73. Dynamic equilibrium in a non-inertial frame.
74. Reasons of deviation of a free-falling bodies.
75. D'Alembert's principle for a particle.
76. Principle central axis of inertia.
77. Equation of motion of the critically damped vibration of a particle.
78. Logarithmic decrement.
79. Kinetic energy in general plane motion.
80. Lagrange-Euler's equation (potential field).
81. Angular momentum.
82. Time rate of change of angular momentum.
83. Principle of conservation of mechanical energy.
84. What is the value of the Coriolis acceleration of point M, knowing that for $t=2$ s,
 $O_1A=O_2B=0.2$ m, $R=0.16$ m], $\varphi = \frac{5}{48} (\pi t^3)$ rad, $s = AM = \pi t^4$ m.



OBJECT ORIENTED PROGRAMMING 1

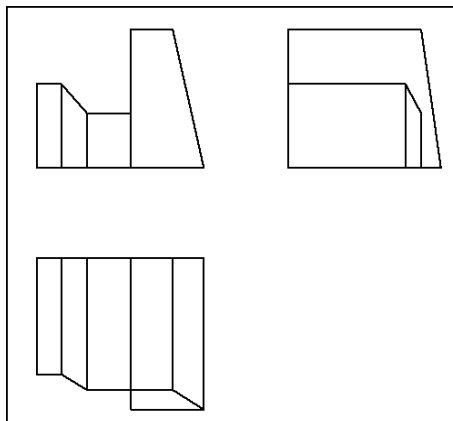
85. Object-oriented programming paradigm comprises the following notions:
86. A C++ class DOES NOT have a property:
87. A constructor in C++:
88. Operator functions in C++:
89. Exceptions in C++:
90. Abstract classes in C++:
91. Interfaces in C++:
92. Inheritance in C++:
93. Templates in C++:

MANUFACTURING PROCESSES

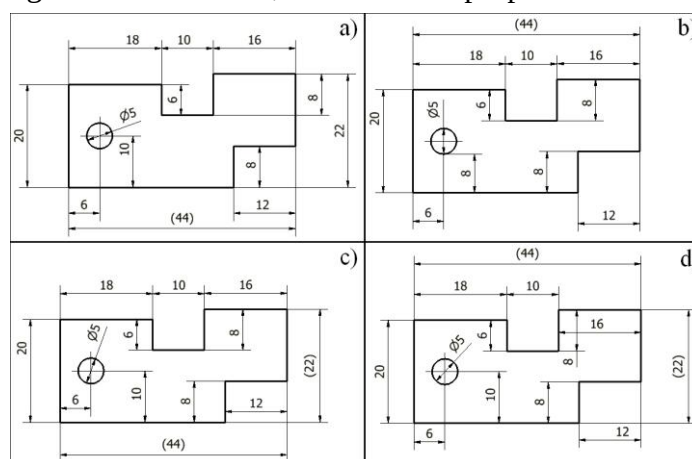
94. What is produced in blast furnaces?
95. What is the range of the carbon content of blast furnace pig iron (an alloy of iron and carbon)?
96. What is produced in oxygen furnaces?
97. What is the content of carbon in steel?
98. What is produced in the process of continuous casting of steel?
99. What is aim of ladle furnace treatments?
100. What is the frit used in the processes of steel?
101. What is the content of pure copper is electrolytic copper?
102. How is produced the aluminum?
103. What is used in the processing of polymer granules?

ENGINEERING DRAWING

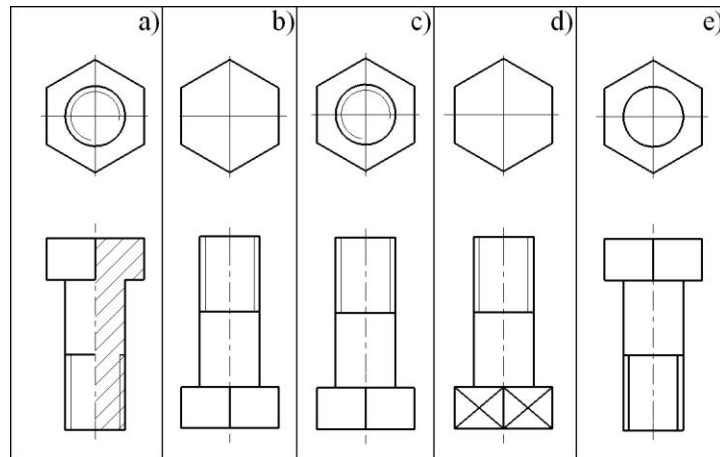
104. Three projections of certain solid are shown In figure below. Please, underline the sentence which describes the drawing correctly.



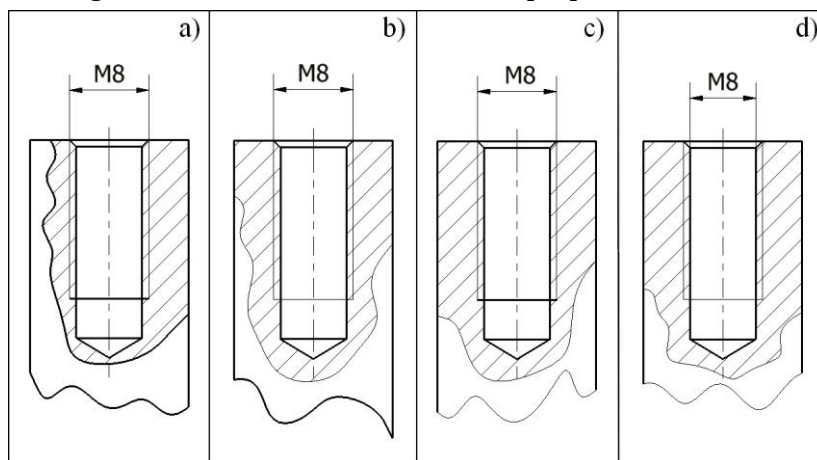
105. Which drawing is correct? Please, underline the proper answer.



106. Which drawing is correctly drawn in 1st angle projection? Please, underline the proper answer.

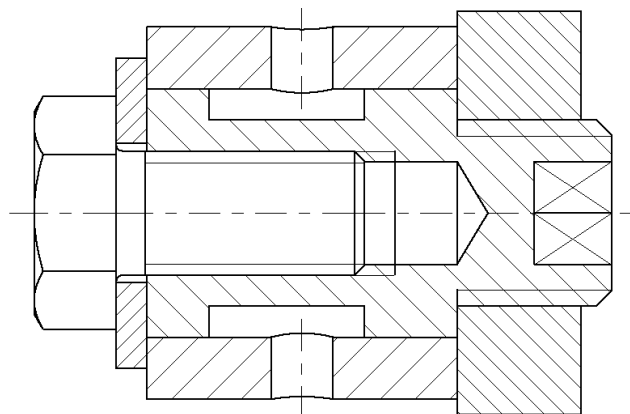


107. Which drawing is correct? Please, underline the proper answer.



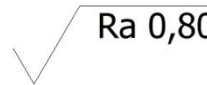
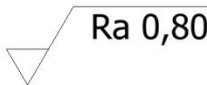
108. Which one from the following descriptions circumscribes properly the bolt with metric thread of nominal diameter 12 mm, made of steel having 400 MPa field stress and 500 MPa ultimate stress?

109. The drawing below shows the section of the assembly of certain elements. How many elements are there in this assembly?

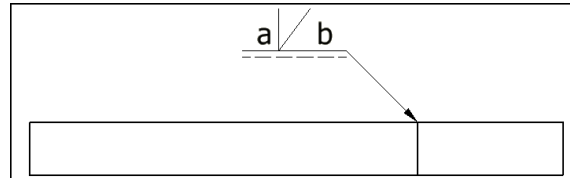


110. Description: $\phi 60$ H7 means:

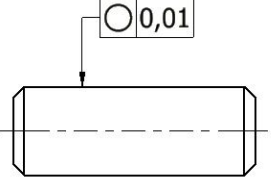
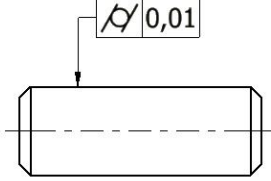
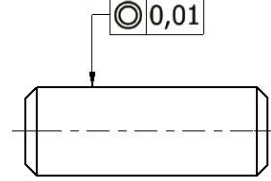
111. There are three different symbols of roughness in the table below, defining the way the specific roughness value has to be obtained. Please underline the row with correct description of these symbols.

I	II	III
		

112. The drawing below shows:



113. Below there are three drawings of a shaft with marked tolerance of shape or position. Please underline the row which gives proper description of the tolerances shown in the table.

I	II	III
		

FUNDAMENTALS OF MATERIAL SCIENCE

114. Increasing the size of the grains in an alloy:
115. Superalloys are metallic materials applied:
116. The basic strengthening mechanism in a duraluminum is:
117. Which strengthening mechanism increases yield strength and simultaneously decreases the Ductile-to-brittle Transition Temperature?
118. The principal element which increases the corrosion resistance of steel is:
119. The weakest of the bonding forces between particles in a solid is:
120. Pearlite in steels is formed:
121. The most efficient strengthening mechanism in metals used in high temperature applications is:
122. The increase of the amount of pearlite in a steel would result in:
123. The phenomenon of brittle fracture of ceramic materials has its roots in:
124. Brasses are alloys of copper with:

STRENGTH OF MATERIALS

125. Prismatic bar is subjected to axial force. What kind of stresses act on the cross-section?

126. Prismatic bar is subjected to axial force. What kind of stresses act on the plane inclined parallel to the axis of the bar?
127. Prismatic bar is subjected to axial force. What kind of stresses act on the inclined plane (the inclination angle $0^\circ < \theta < 90^\circ$) ?
128. What kind of stresses are considered in connections that use welds?
129. The neutral surface in pure bending of a prismatic beam is the surface which:
130. A prismatic round steel bar of the diameter $d = 20$ mm is subjected to tension with the axial force $F = 56.5$ kN. The normal stresses in the cross-section are equal to:
131. The maximum bending moment in the prismatic simply supported beam of the length l symmetrically loaded with the concentrated force F is expressed as:
132. Moment of inertia of the square of the side a is expressed as:
133. What is the qualitative difference between the torsion of a round prismatic bar and the bar of a noncircular cross-section?
134. What is the qualitative difference between the pure bending of a prismatic bar and the non-uniform bending of the same bar?

CONTROL THEORY FUNDAMENTALS

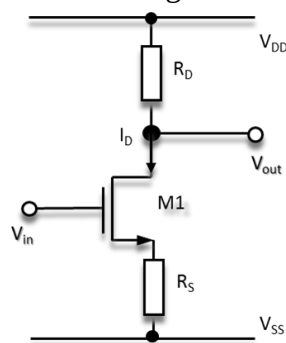
135. What kind of forcing signals are applied when determining the time-domain characteristics of elements and automation systems?
136. Which statement is used to designate the transform of sum over time function?
137. What is the transform of convolution of two time functions with a known transform?
138. Which dependence shows the of transfer function (transition function) of an element (term) or automation system?
139. What form has the denominator of inertial element (term) transmittance of 1st order?
140. What form has the denominator of inertial element (term) transmittance of 2nd order?
141. What kind of element (term) is an object with self-balancing?
142. What is the relationship between the impulse response and step response of an element (term) or automation system?
143. What kind of parameters (coefficients) contains the transfer function of an inertial term of 1st order?
144. What kind of parameters (coefficients) contains the transfer function of a perfectly integral term?
145. What part due to the equation's order is the real integral term?
146. What kind of parameters (coefficients) contains the transfer function of an oscillatory term of 2nd order?
147. What kind of answer to the step input signal generates an inertial element (term) of 1st order, due to the amplitude of vibration?
148. What kind of answer to the step input signal generates an oscillatory element (term) of 2nd order, with the damping number $0 < \xi < 1$, due to the amplitude of vibration?

149. What causes the increase in attenuation number in the transmittance of the oscillatory element (term) of 2nd order from the values eg. 0.1 to 0.4 respectively to over-regulation of the step time characteristics?
150. In which case the oscillatory element (term) of 2nd order has a step characteristic with the damped vibrations?
151. From which set of time characteristics is created frequency characteristic of an element (term) or the system?
152. What is the shape of step response of a perfectly integral element (term)?
153. What is the value in the steady state of the actual step response of derivative element (term)?
154. Is the output signal from the open control systems is used to improve the response of these systems? If so, how it is done?
155. Is the output signal from the controller systems is used to improve the response of these systems? If so, how it is done?
156. What kind of feedback typically occurs in controller systems?
157. What is an offset adjustment in the systems of unit feedback?
158. How do we determine replacement transmittance of two elements (terms) connected in series?
159. How do we determine transmittance of replacement of two elements (terms) connected in parallel?
160. What characterizes the output signal of stabilization (with fixed values) control systems?
161. What characterizes the output signal of tracking control systems?
162. For what purpose can be used amplitude-phase characteristics of an open loop system?
163. What is the necessary and sufficient condition for asymptotic stability of control system, applied to the roots of the characteristic equation?
164. What condition is obligatory in the Nyquist stability criterion?
165. For what purpose the controllers are used in control systems?
166. At what point of control system the controller should be placed?
167. At what point of control system the measuring member should be placed?
168. How the principle of superposition is formulated?
169. When the element (term) or the control system is called linear?
170. Is it possible to introduce the changes to the flow chart that contains two linear elements (terms) connected in series?
171. What kind of the negative feedback is called a rigid?
172. What kind of the negative feedback is called a flexible?
173. Which roots of the characteristic equation cause in time-domain characteristic the vibrations with constant amplitude and frequency?
174. What is the linearization of the mathematical model?
175. What method of linearization is often used for static characteristics?

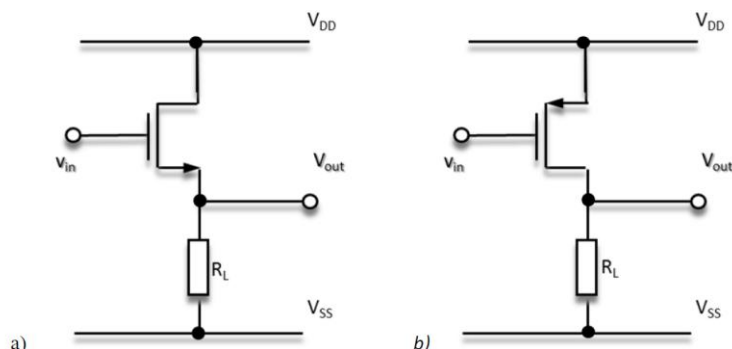
176. What method of linearization is often applied to the dynamic relationships?
177. Which way of describing an element (term) or the automation system is the most complete description?
178. Control system is described in the state space by following equations:
 $\dot{\mathbf{x}}(t) = \mathbf{Ax}(t) + \mathbf{Bu}(t)$
 $\mathbf{y}(t) = \mathbf{Cx}(t) + \mathbf{Du}(t)$
 Which of the matrix is a input matrix (control)?
179. Control system is described in the state space by following equations:
 $\dot{\mathbf{x}}(t) = \mathbf{Ax}(t) + \mathbf{Bu}(t)$
 $\mathbf{y}(t) = \mathbf{Cx}(t) + \mathbf{Du}(t)$
 Which of the matrix is a state matrix?
180. Control system is described in the state space by following equations:
 $\dot{\mathbf{x}}(t) = \mathbf{Ax}(t) + \mathbf{Bu}(t)$
 $\mathbf{y}(t) = \mathbf{Cx}(t) + \mathbf{Du}(t)$
 Which of the matrix is a output matrix (response)?

ELECTRONIC CIRCUITS

181. Using Zener diode for $U_Z = 12\text{V}$ is observed that current chngement of 12 mA causes a change of voltage stabilization by 0.12V. Dynamic resistance of the diode in this range is:
182. The NMOS transistor threshold voltage U_T is 0,55 V. If the $U_{GS} = 1,00\text{ V}$, $U_{DS} = 2,35\text{V}$, The NMOS operates in region:
183. The gain of voltage amplifier shown in figure below:

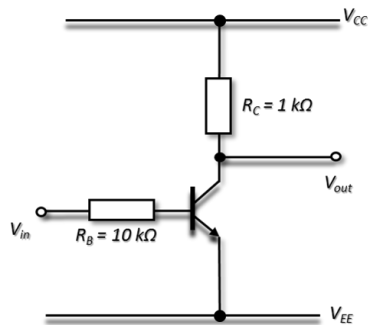


184. Which of the circuits is the source follower?

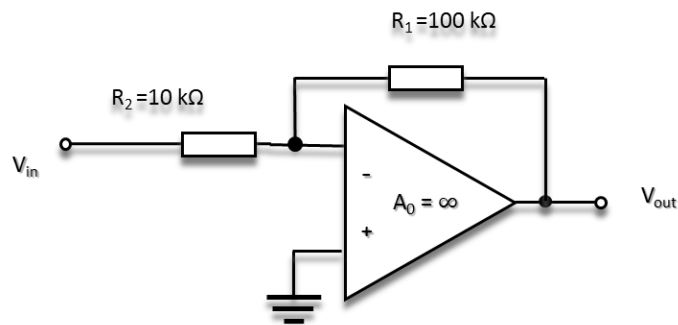


185. How do we bias the laser diode and LED?

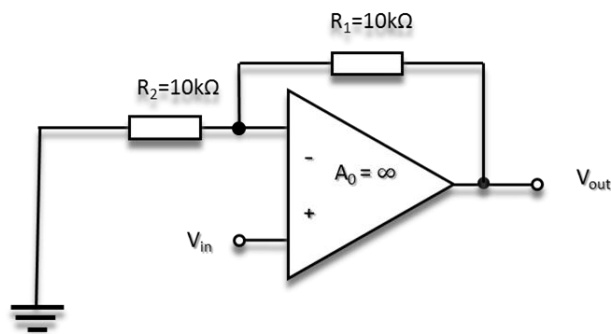
186. Voltage gain of the amplifier shown in the figure below, which uses transistor with $\beta = 70$ is:



187. What is the gain of the circuit with operational amplifier shown in the figure below:

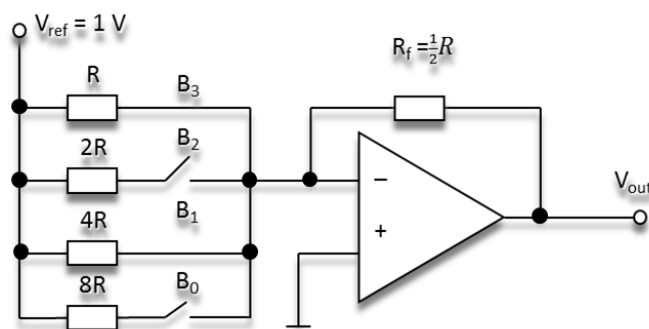


188. What is the gain of the circuit with operational amplifier shown in the figure below:

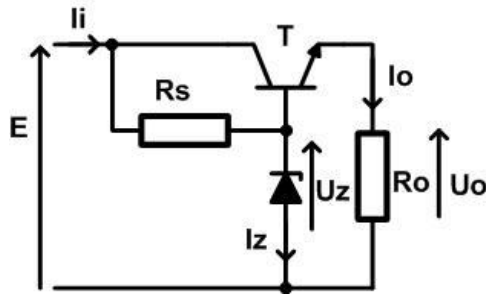


189. The Shannon-Kotelnikow theorem for the lossless conversion of analog signals to digital one determines:

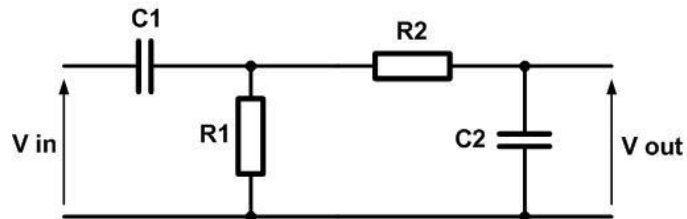
190. What is the voltage at the output of 4-bit DA in configuration shown in the figure below?



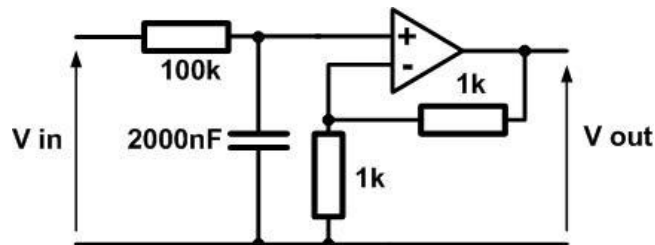
191. Series voltage regulator is presented in the figure below. $U_z = 4.7\text{V}$, $U_{be} = 0.7\text{V}$. Output voltage (U_0) is:



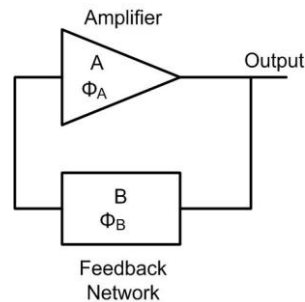
192. What kind of passive filter is shown in the figure below?



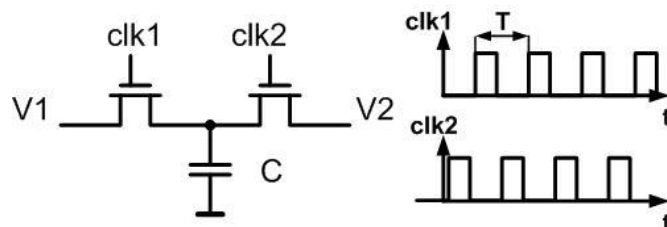
193. Active filter is presented in the figure below. K- amplification and f_g - cutoff frequency are:



194. What are the conditions of oscillation in circuit which is shown in the figure below?
(A- gain of amplifier, B- gain of feedback network, ϕ_A - phase shift through the amplifier, ϕ_B -phase shift through the feedback network)



195. Electrical circuit presented in the figure below is used to build:



NUMERICAL METHODS AND STATISTICS

196. Cutting errors (resulting from stopping the process of limit computing before obtaining the limit value) does not appear while:

197. Indicate incorrect definition of numerical algorithm.
198. In the floating point notation, value of number x can be calculated using the formula $x = S \cdot M \cdot B^E$, where:
199. In numerical analysis, for the purposes of solving sets of linear equations, we use:
200. LU decomposition method can't be used for the purposes of:
201. Indicate the statement that does not describe bisection method:
202. Accuracy and precision of the results of numerical calculations.
203. Variance:
204. In Newton-Cotes methods of numerical integration (e.g. in trapezoid rule, Simpson's rules) integrand is:
205. For the purposes of numerical differentiation the following methods are used:

FUNDAMENTALS OF DESIGN OF MECHANISMS IN MECHATRONIC DEVICES

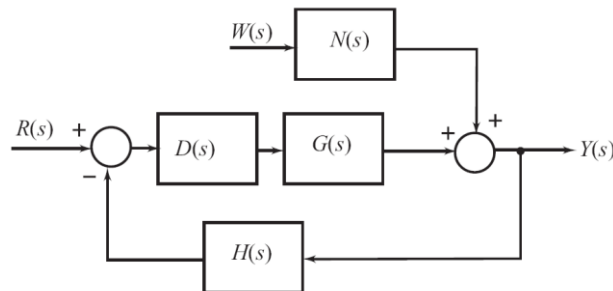
206. How many degrees of freedom have links forming a kinematic pair of 4th class?
207. How many degrees of freedom have links forming a kinematic pair of 5th class?
208. Which class of kinematic pair is ball joint?
209. What we call an open kinematic chain?
210. What we call a closed kinetic chain?
211. Which form has the formula for the theoretical mobility of the plane mechanism?
212. What form has the formula defining the theoretical mobility of spatial mechanism?
213. What is a local mobility?
214. How many drives should be used for the mechanism with real mobility equal $w = 3$?
215. Which of the conditions must be fulfilled by the correct replacement mechanism diagram?
216. What kind of motion performs a connector in crank-slide mechanism?
217. What kind of motion performs a connector in four bar linkage mechanism (special case of an articulated quadrilateral four bar linkage)?
218. Which of the kinematic and geometrical parameters must be known to calculate the normal acceleration of a point belonging to the link of the mechanism?
219. Which form has the formula for the normal acceleration point belonging to the link of the mechanism?
220. In the case of which mechanisms we can say of a complex motion of links?
221. For what listed below mechanisms occurs the Coriolis acceleration?
222. Which form has the formula for the Coriolis acceleration for the point belonging to a link performing the complex motion?
223. Identify the steps in grapho-analytical method of kinematic analysis.
224. Identify the steps in analytical method of kinematic analysis.
225. What differs the epicyclic gearing (or planetary gearing) from the spur transmission gear?

226. An axle is a machine part that is used to:
227. The angle of twist (angular deflection) φ for a uniformly loaded plain shaft subject to torsion is calculated by
228. Cylindrical roller thrust bearing can be used to:
229. Desired bearing life in hours can be expressed by the following formula:
230. To support a rotating member that exerts moderate radial loads and small axial loads we can use:
231. A screw with length 70 mm, metric thread with nominal diameter 10 mm and strength class that provides nominal tensile strength equal to 500 MPa and yield strength equal to 400 MPa can be marked by:
232. Where the critical stress occurs in an axially loaded steel bolt assembled with a steel nut with a height $H = 1.0d$?
233. Calculate maximum allowable axial force that can be exerted on a screw with thread M6x0.75. The thread diameter is given $d_r = 5.0$ mm and the screw is made of material with allowable stress $k_r = 200$ MPa
234. Select a welding symbol that designates filled weld with throat thickness equal to 3 mm that is made on site of the assembly on the entire circumference of the element. The weld face should be flat.
235. A cylindrical fit is specified by the following letter code $\varnothing 100 H7/h6$. The deviations are known: $ES = 35 \mu\text{m}$, $ei = -22 \mu\text{m}$. Calculate maximum clearance for the connection.
236. Calculate distance between axes for a pair of spur gears with known number of teeth $z_1 = 22$, $z_2 = 28$ and module $m = 4$ mm.
237. The relation between tensions if flat belt transmission is expressed by the following formula:
238. The flat belt transmission does not have the property:
239. Belt transmissions cannot be characterized by:
240. Double Cardan coupling:
241. Which type of springs is the best suited to exert high compression force with low deflection?

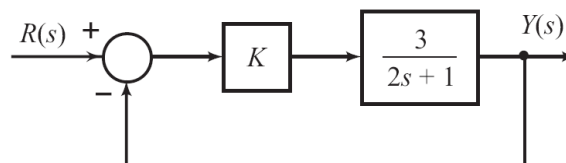
CONTROL THEORY

242. Feedback control systems are:
243. Consider the following statements:
- If an open-loop system is unstable, applying feedback will always improve its stability.
 - If an open-loop system is subject to parameter variations, applying feedback will always improve robustness.
- Which of the following is the correct answer?
244. For a second-order system with damping coefficient $\zeta > 1$, the roots of the characteristic equation are:

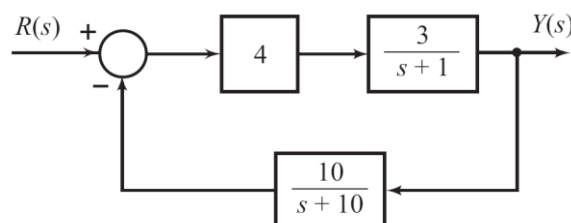
245. The percentage overshoot of a second-order system $G(s) = \frac{K\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$ to a step input depends only on:
246. A proportional controller K_p is used with a first-order system $G(s) = K/\tau s + 1$ in unity negative feedback structure. Increasing K_p will:
247. An integral controller K_I/s is used with a first-order system $G(s) = K/\tau s + 1$ in unity negative feedback structure. Increasing K_I will:
248. A temperature control system is found to have zero error to a constant tracking input, and an error of 0.5°C to a tracking input that is linear in time, rising at the rate of $40^\circ\text{C}/\text{sec}$. What is the type number of the system?
249. A unity negative feedback system has open-loop transfer function $G(s)$. The steady-state error is zero for:
250. Given that the open-loop system is stable. If the Nyquist plot of the open-loop system does not encircle the point $(-1, j0)$ then one can state that
251. Given a state variable model $\{A, b, c\}$ of a single-input, single-output system. The asymptotic stability is determined from:
252. Consider the block diagram below. The transfer function between $Y(s)$ and $W(s)$ is:



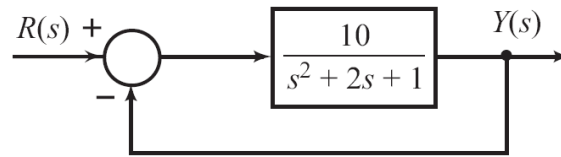
253. Select the best value of K that makes the time constant of the system in the following figure (approximately) equal to 0.2 seconds.



254. A linear time-invariant system initially at rest, when subjected to a unit-step input, gives a response $y(t) = te^{-t}$; $t > 0$. The transfer function of the system is:
255. The characteristic equation of the closed-loop system shown in the following figure is:



256. Which of the following describes the step response of the closed-loop system shown in the figure below:



257. The condition that all the roots of the polynomial $\Delta(s) = a_0s^3 + a_1s^2 + a_2s + a_3$ where $a_0, \alpha_1, \alpha_2, \alpha_3 > 0$ have negative real parts, is given by:

258. A state variable formulation of a system is given by the equations:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

The transfer function of the system is:

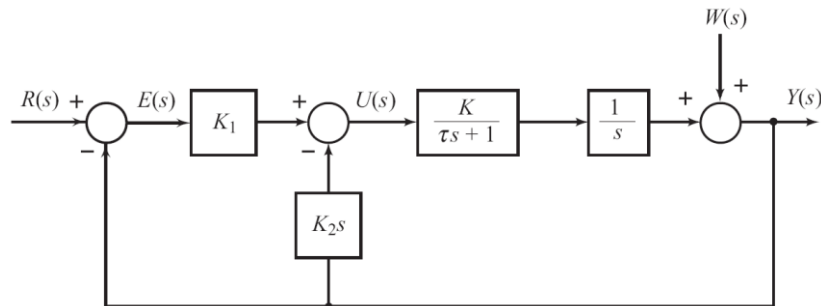
259. A state variable model of a system is given by the equations:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ -2 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

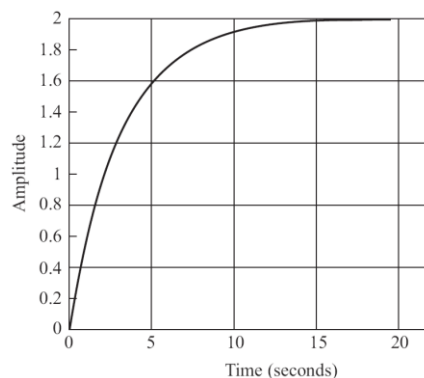
$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

The system is:

260. The transfer function from $R(s)$ to $Y(s)$ of the system shown below is:



261. The plot in the following figure shows the unit step response of a first-order system. Transfer function of the system is:



BASICS OF MECHATRONICS

- 262. What is a virtual prototyping?
- 263. What is rapid prototyping?
- 264. What is the morphological analysis?
- 265. What means the concept of synergy?
- 266. What is the stability analysis of discrete systems using the Z-transform?
- 267. Simulation studies proper operation and ownership of the proposed system prior to the mechatronic device prototype.
- 268. Time to Market means the period from conception until the product launch. What is the impact of virtual prototyping on this process?
- 269. Multi branch simulations are an important part of the process of mechatronic design. What is the origin of these simulations name?
- 270. How is implemented mechanically precise rotary motion with a resolution of fractions of a nanometer?
- 271. What is a typical range of deformation motion of the piezoelectric actuator?
- 272. What is the typical working range of voltages used in piezoelectric actuators?
- 273. What order of magnitude of the maximum force can reach a piezoelectric deformation actuator?
- 274. What is the diameter of the smallest commercial rotary DC motor?
- 275. How many words could be fit at the surface of 0.5 square millimeters?
- 276. How big is the smallest autonomous wheel micromanipulator?
- 277. With the help of what the device can accurately visualize the surfaces of microscopic size?
- 278. What is the principle of work of the resonant piezoelectric motor?
- 279. What is the maximum resolution of resonant drive motion?
- 280. What is emulation?
- 281. What is meant by the term mechatronics?
- 282. What is mechatronic design process?
- 283. What is software CAE (Computer Aided Engineering)?
- 284. What is the Rigid Body model?
- 285. What does it mean that the mechatronic device operates in real time?

OBJECT ORIENTED PROGRAMMING LANGUAGES / MODELING OF OBJECT ORIENTED SOFTWARE

- 286. What is an Abstract method?
- 287. What is Virtual method?
- 288. What is Polymorphism?
- 289. What for are static method?
- 290. What is class?
- 291. What is an interface in Object Oriented Programming?

- 292. What is encapsulation?
- 293. What is hashtable (dictionary in some languages)?
- 294. What is inheritance?
- 295. What languages are not using weak typing?
- 296. Properties of set.
- 297. What is SOLID?
- 298. What is TDD?
- 299. What is relationship between a class and an object?
- 300. What is stack?

ACTUATING, SENSING AND CONTROL MECHATRONIC SYSTEMS

- 301. Accuracy and resolution of a sensor:
- 302. Incremental encoders are used for direct measurements of:
- 303. The dominant reason of resistance changes:
- 304. Voltage induced in a tachometer generator is rectified with:
- 305. The output quantity of transducers based on direct piezoelectric effect is:
- 306. Inertial sensors are:
- 307. Dark current in CCD image sensors is caused by:
- 308. For a power driver, piezoelectric actuators working at low frequencies, behave as:
- 309. In a case of cyclic movement of a piezoelectric actuator:
- 310. The task of the external electronic commutator in Permanent Magnet Synchronous Motor (PMSM) is:
- 311. MEMS micromachining:
- 312. Seismic transducer is used in:
- 313. Thermoelectric thermometers operate utilizing:
- 314. Linear variable differential transformer is used to measure:
- 315. Combinatorial circuits are:
- 316. A FSM (Finite State Automaton) is:
- 317. RAM is:
- 318. Dynamic memories:
- 319. A useful microprocessor system must contain at least:
- 320. Control instructions of a microprocessor are used to:
- 321. Serial synchronous transmission is a transmission with:
- 322. Compiled C language program functions can use the microprocessor stack for:
- 323. Architecture of a microprocessor system with separate system buses for instructions and data:
- 324. The use of program cache memory:
- 325. The name “Little Endian” specifies how:
- 326. Canonical form of combinational logic functions is:
- 327. Signal propagation time between any given two points in the FPGA chip:

- 328. Direct memory access (DMA) consist in:
- 329. How to change the speed of a DC motor?
- 330. How to change the direction of rotation of a DC motor with permanent magnet stator?
- 331. The highest starting torque has DC motor with:
- 332. Microstepping.
- 333. What does PWM mean?
- 334. The inverter is used to:
- 335. Rectifier is used to:
- 336. How many diodes is required to build a three phase full-wave rectifier?
- 337. Hydraulic motor transforms into mechanical energy:
- 338. Force in pneumatic actuator is:
- 339. Starting moment for a synchronous drive:
- 340. Reluctance drive:

VIRTUAL PROTOTYPING IN DESIGN

- 341. Explain the meaning of 'virtual prototyping'.
- 342. The use of virtual prototyping in the design process allows for:
- 343. Explain the meaning of Product Lifecycle Management (PLM).
- 344. Explain the concept of 'verification' in the context of computational mechanics.
- 345. Explain the concept of 'validation' in the context of computational mechanics.
- 346. What is the Finite Element Method (FEM)?
- 347. What are the 'shape functions' in Finite Element Method (FEM)?
- 348. What are the Multibody Simulations (MBS)?
- 349. Explain the meaning of the 'synergy' concept.
- 350. What is the concept of 'morphological analysis' in mechatronic design?
- 351. Explain the concept of 'multiscale simulations'.
- 352. Explain the concept of 'multiphysics simulations'.
- 353. Explain the design paradox related to the knowledge gained about the product and the flexibility in introducing design changes.
- 354. Should the manufacturing technology be considered during the geometry modeling stage or later in the final design stages just before manufacturing.
- 355. Explain the term Computer Aided Engineering (CAE).

INDUSTRIAL ROBOTS / SERVICE ROBOTS

- 356. Definition of a Robot Manipulator.
- 357. For what purpose is used a simple kinematics problem?
- 358. For what purpose is used an inverse kinematics problem?
- 359. Basic robot systems.
- 360. What kind of configuration is anthropomorphic type of manipulator?
- 361. What kind of configuration SCARA type of manipulator?

362. What is a service robot?
363. What is the appropriate form of the criterion of the robot design quality assessment?
364. What is the number of degrees of freedom of a robot end-effector?
365. What is the mobility of the robot manipulator kinematic chain?
366. What is the definition of the robot nominal load?
367. What is the robot manipulator positioning accuracy?
368. What is the robot manipulator positioning repeatability?
369. Why the variability of the robot manipulator positioning accuracy is determined in practice?
370. Compare values of positioning accuracy and positioning repeatability of nowadays robots?
371. Which measuring devices are used for the most precise determination of the robot positioning repeatability during motion?
372. What is the principle of a robot end-effector position measurement with use of the laser tracker?
373. What is the aim of the absolute calibration of the manipulating robots?
374. Explain what the geometrical (functional) absolute calibration of the manipulating robot consists in?
375. What information about the pose is presented by the elements of the homogeneous transformation matrix?
376. How are the Euler RPY angles used to express orientation of an end-effector in a manipulator workspace?
377. Which kinematic structures of the manipulator arm are used the most often in practice?
378. Which kinematic structures of the manipulator arm are of the closed-loop type?
379. What is the kinematic diagram of the Euler wrist?
380. What features the electrical driving systems of the robot manipulators possess when compared to the fluid drives?
381. What disadvantageous properties possess the compressibility of the air in the pneumatic driving systems of manipulators?
382. What is the applicability of the hydraulic driving systems in robot manipulators?
383. Why the low inertia rotor electric motors are recommended to be used in robot manipulators?
384. Which of the electric motors is a typical low inertia one recommended to be used in robots?
385. What should accompany the stepping motors in application in robot manipulators?
386. What has made the application of the AC asynchronous motors in robot manipulators effective?
387. Why the harmonic gearboxes are recommended to be used in robot manipulators?
388. What construction materials are recommended to be used to manufacture robot links from the point of view of the mechanical properties of the links?

- 389. What are the most important advantages of aluminium for its use in manufacturing of robot links?
- 390. What technology is used the most often in manufacturing of links of robot manipulators?
- 391. What is the technique of preloading manipulators' joints and links applied for?

MECHATRONIC DESIGN

- 392. Parallel design in Mechatronic is:
- 393. Reproductive compliance of the model allows to:
- 394. The acronym CAD stands for
- 395. The acronym CAE stands for
- 396. The acronym CAM stands for
- 397. Which of the method is not 3d printing method:
- 398. Which of the method allows for 3d printing based on metals
- 399. Stereolithography is a method of
- 400. Which mechatronic definition is correct
- 401. Rapid prototyping of the control systems may be performed on:
- 402. Hardware-in-the-Loop method allows for:
- 403. One of the morphological analysis phases is
- 404. Which of the method may be used in morphological analysis?
- 405. Real time simulation may be performed in:
- 406. Digital Signal Processor are based on architecture
- 407. Smart material is:
- 408. The MEMS system is:
- 409. Photolithography is:
- 410. Modular robots are:

IDENTIFICATION AND SIGNALS ANALYSIS

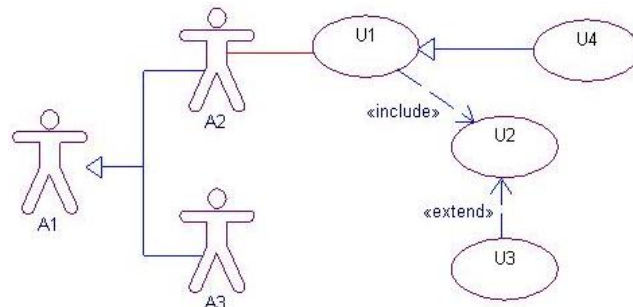
- 411. What is the eigenvalue problem?
- 412. What is the method of least squares?
- 413. How to choose the specific rows of polynomials during the identification of parametric models?
- 414. Indicate which of the following methods are not based on signal processing in the frequency domain.
- 415. What is the phenomenon aliasing in signal processing?
- 416. Indicate, what is the purpose of time window use in signal processing?
- 417. What type of signal processing methods should Wavelet Transform belong to?
- 418. What is the matrix A in the equation of state saved in the form $\dot{x}(t) = Ax(t) + Bu(t)$?
- 419. What we call the system transfer function?
- 420. What we call the modal model?

COMPUTER AIDED MANUFACTURING

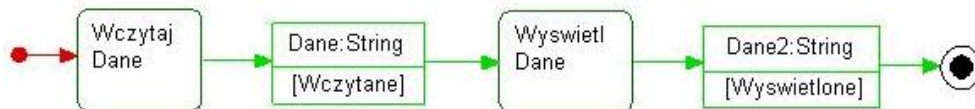
421. Computer Aided Manufacturing software.
422. Basic concepts of CAD/CAM
423. Solid and surface modeling in the 3D space
424. Computer aided milling
425. Computer aided turning
426. Machining process simulations in CATIA V5
427. Manufacturing of plastic products in injection molds.
428. Advanced CAD/CAM methods.
429. Manufacturing process configurations.
430. Operations of a machining process – basic terms.

SOFTWARE ENGINEERING

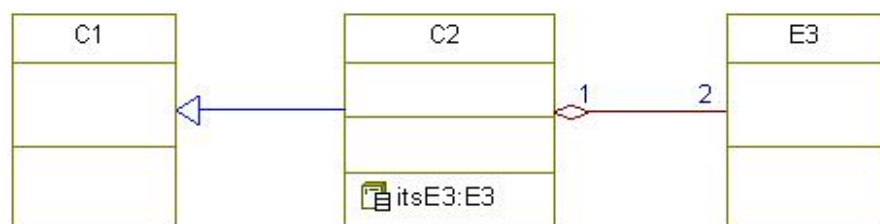
431. The UML diagram shown below is:



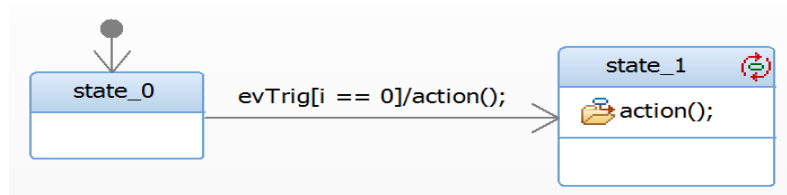
432. The UML diagram shown below is:



433. In the UML diagram shown below, the class C2 will:

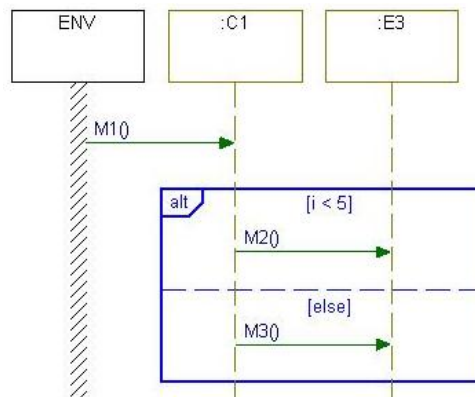


434. In the UML diagram shown below, transitioning from state 'state_0' to state 'state_1' will result in:



435. The symbol of UML state may include:
436. The UML state machine diagrams may include:

437. The UML diagram shown below defines:

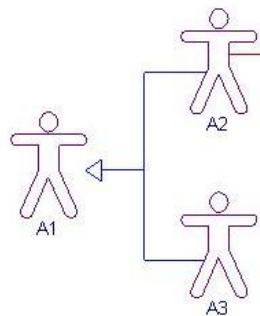


438. A UML activity diagram may include:

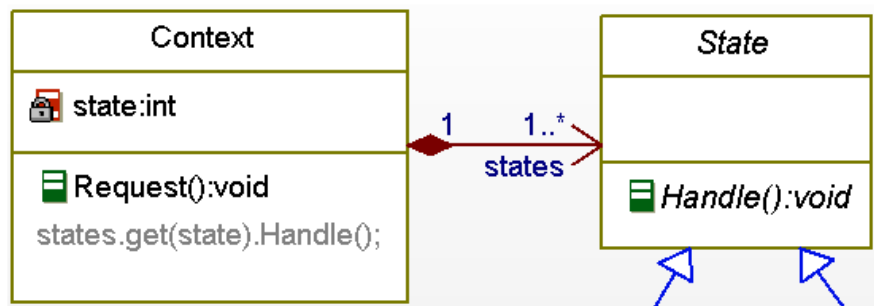
439. In the UML diagram shown below:

440. Flows in the UML activity diagrams may be annotated with:

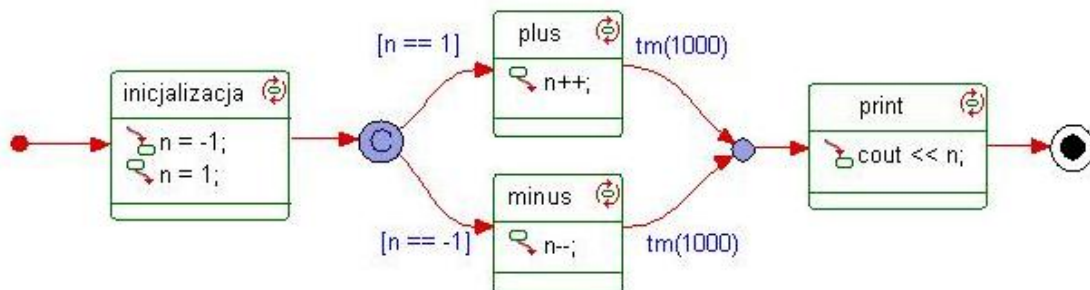
441. A relationship between elements A1 and A2 in the following UML diagram is:



442. The following UML diagram represents a pattern:



443. When executing the following UML diagram, the 'print' state will display the value of variable 'n' equal to:



444. The Element E6 on the following UML diagram is:



VISION SYSTEMS / VISION TECHNIQUES

- 445. Image binarization.
- 446. Image histogram.
- 447. Image equalization.
- 448. Results of square root of function:
- 449. Results of image logarithm:
- 450. Results of power function:
- 451. First row of the Prewitt operator:
- 452. First row of the Sobel operator:
- 453. Morphological opening:
- 454. Morphological closing:
- 455. Laplasjan operator:
- 456. Second order moment of an analyzed object:
- 457. K-means clustering is used for:
- 458. Image segmentation.
- 459. Image analysis.
- 460. Image feature.
- 461. Internal matrix of camera calibration contains:

NEURAL NETWORKS AND FUZZY SYSTEMS IN ENGINEERING / GENETIC AND EVOLUTIONARY ALGORITHMS IN ENGINEERING

- 462. In which range are scaled the fuzzy membership functions ?
- 463. Does intersection function consisting of two fuzzy sets mean:
- 464. Fuzzy model where the consequences of fuzzy rules have a form of fuzzy logic sets is called the model:
- 465. Fuzzy controller consists of :
- 466. Dynamical fuzzy controller requires the following signal(s):
- 467. In multilayered neural networks, layers between input layer and output layer are called:
- 468. In Supervised training the main idea is:
- 469. How the information about network output correctness is provided to the network in unsupervised training

470. The benefit of neural networks application in modelling and control is:
471. Hopfield neural network is an example of:

COMPUTER NETWORKS AND DATABASES / INFORMATION TECHNIQUES IN ENGINEERING PRACTICE

472. What is SSH?
473. Indicate the main differences between FTP and SFTP?
474. What is the SFTP?
475. What is the command syntax listing the directory contents?
476. What enables the FTP service?
477. What is type in the browser window, when we connect in graphic mode (GUI) to the server ftp of address ftp.microsoft.com?
478. Is the number within the smallest subnet that occurs in the IP address \149.156.96.9\ may be valid, and what mean the various numbers?
479. What is HTML?
480. Indicate to the so-called character part of the header of the document, which contains information about the document that is not displayed, but they can be used for example by Internet search engines. (What markers are limiting it?)
481. For what purpose is used SQL language?
482. What does it mean to declare a field as primary key

OPERATION OF MECHATRONIC DEVICES / SYSTEMS OF MECHATRONIC DEVICES MONITORING

483. What is the relationship between expenditures on monitoring and maintenance costs?
484. What does the term „preventive maintenance” mean?
485. What does the term „predictive maintenance” mean?
486. Which statement best describes the CMMS system?
487. Acoustic emission.
488. What parameter of mechanical vibration is the best indicator of the misalignment of shafts?
489. Which shortcut parameter describes the mean time between failures devices?
490. What does the abbreviation SIL mean?
491. What is the purpose of application of machinery monitoring systems?
492. For which tasks can be used infrared camera?
493. What parameter of mechanical vibration is the best indicator of the rotor unbalance?
494. For what purpose is used analysis of the envelope of mechanical vibrations signal?
495. Which of the following statements is FALSE with respect to the accelerometer?

COMPOSITE STRUCTURES AND THEIR APPLICATIONS

- 496. Composite materials:
- 497. Strength properties of carbon/epoxy composites depend on:
- 498. Symmetrical and balanced laminates have properties.
- 499. Short fiber reinforced injection molded composite materials:
- 500. Glass transition temperature of polymeric material is:

EXPERIMENTAL METHODS IN TESTING OF MECHATRONICS SYSTEMS

- 496. The full spectral resolution depends on:
- 497. For a steady-state, in which an object generates vibrations, resonant frequencies of an object:
- 498. Representation of the frequency response function in time domain is:
- 499. By identifying the poles of the mechanical system we can determine:
- 500. In case of modal model local object parameters are described by: